ing force, will deepen, and in consequence apparently feeble depressions are often transformed into true storms.

But the problem is not only to predict whether a depression will fill up or deepen; nor is it sufficient to indicate the extent to within a few millimeters of the variations of pressure in cyclones; it is also necessary, in order to make a more or less perfect forecast of the weather, to establish *the velocity and the path of the center of the depression*—things which no method of forecasting has, up to the present time, enabled us to determine.

The principle which guides us in this estimate—and which is only a consequence of the first—is thus exprest: *The depression moves toward the region of least resistance.*

These favorable areas will evidently be made up of zones where the winds are *proportionally* too light for the gradient, and, above all, of regions where the winds are *divergent* with reference to the center of the depression considered.

Hence, every barometric low which is prest on one side by winds *abnormal by excess* will move toward the region of least resistance; whether this region be to the north, to the south, to the east, even to the west of the center; and often *whatever may be the distance from the center to this region.* This is the explanation of the apparently capricious directions followed by certain tempests; and it is, at the same time, the basis for predicting the translation, sometimes to prodigious distances, of the centers of storms.

To summarize, in the principle of the *normal wind* we have a safe and rational basis, not only for predicting barometric variations, but for determining whether a depression will or will not assume importance; whether it will fill up or deepen; whether it will retrograde or advance rapidly along a path more or less regular. We can, in addition, establish with sufficient approximation, the region which ought to be covered by the center of the depression on the following day; hence these three problems of the *extent*, the *direction*, and the *velocity* of the motion of storms are completely solved.

This is not sufficient. It is of importance to establish the regions where the rise and fall of pressure will attain their *maximum* intensity. These maximum variations do not always correspond to the maximum and minimum pressures. It is in the region of *least resistance*—or where the winds are simply light—that we locate these oscillations (maximum rise or fall). But we wish to be still more precise and even indicate the stations which will record, on the following day, the maximum rise and fall within the twenty-four hours.

This problem, the most interesting of all perhaps, is solved by the aid of this hypothesis: *The air flows in a direction perpendicular and to the right of the wind which is proportionally too strong.* Therefore the maximum rise or fall takes place *in a straight line* in this direction [i. e., perpendicular to the excessive wind]. Consequently, if the *converging* winds bring the air, or at least the pressure, straight toward the center, *along the gradient*, normal to the isobars, and tend to fill up the center—just as if the cyclonic system were stationary and independent of the rotation of the earth—then the *diverging* winds operate in an opposite direction. Instead of concentrating the pressure they produce a dispersion, that is to say, a void, and this void *is a re-pression.* We approach here very closely the cause of the origin of cyclones. Moreover, the application of our principles and of our hypothesis to the examination of anticyclones enables us to forecast their formation and *their dissipation.*

As the movement of cyclones and of anticyclones determines in general the force and the direction of winds and nearly all the phenomena of heat or cold, of rain or fine weather, of cloudiness or humidity, the principle of the *normal wind*, with its natural consequences, *creates*, in the literal sense of the word, a new method of forecasting the weather.

It is immediately applicable to the synoptic charts, such as those of the Central Meteorological Bureau of France, without introducing any modification.

Certain progress will be the consequence of this application, as our principles are applicable at all times of the year, and the rare errors that occur in practise are due, not to the principles, but to the inexperience of the interpreter, or to the difficulties which result from the simultaneous occurrence of several depressions, or to the sudden arrival of storms from the ocean.

Clouds, or the *succession of clouds*, as we demonstrated in 1886, announce the approach of these oceanic depressions. Once upon the continent, they can be followed by our method. The art of weather forecasting, empirical up to the present time, without strict rules, and based upon an incommunicable personal experience, will then become scientifically established.

OBSERVATIONS OF HALOS AT COLUMBIA, MO.

By GEORGE REEDER, Section Director. Dated Columbia, Mo., May 21, 1907.

My observations of halos at Columbia, Mo., have been carefully made and recorded, and I have found that halos are a very good guide in predicting weather changes, especially the 22-degree circles. I have noted that when the 22-degree circle is observed precipitation usually occurs within twelve to eighteen hours, the storm center crossing the meridian near the point of observation. In such cases the upper clouds undergo rapid changes, becoming thick and matted as they change from cirro-stratus to alto-stratus. When the 45-degree circle is observed the storm center is usually from 800 to 1000 miles or more away and precedes precipitation, if any, by twenty-four to thirty-six hours. I have known the 45-degree circle to continue for three hours or more, with colors well defined, the cirro-stratus clouds being apparently of the most delicate texture and changing their form slowly. If the center of disturbance is directly west of the point of observation, or nearly so, the 45-degree circle may be taken as a very sure sign that precipitation will occur within the succeeding thirty-six hours at this station; but it frequently happens that the storm center crosses the meridian far to the south, and then precipitation does not occur at the point of observation. Well-defined 45-degree circles have been observed around the sun at this station when a West Indian hurricane was immediately off or near the east Gulf or South Atlantic States, but of course in such cases no precipitation occurred at the point of observation. A very brilliant solar halo on September 27, 1906, was the first indication that a Gulf storm was moving northward, entering the mainland near the mouth of the Mississippi River. The storm moved up the valley quite rapidly, and rain was falling over the greater part of Missouri just twelve hours after the halo was observed.

The following are the dates upon which halos were observed during the years 1905 and 1906. February, 1905, was abnormally cold and solar halos were unusually numerous:

January 5, 1905, 10 a. m., solar halo, 22°, bright for one hour. Snow on the 6th.

January 8, 1905, 9 a. m., solar halo, 22°, bright and well defined until 9:30 a. m., disappeared at 10 a. m. Snow began falling at 7:45 p. m. same day, continuing into the night.

January 14, 1905, 2:35 p. m., solar halo, 22°, not well defined, very faint in its lower half. Cold and clear on the 15th.

January 28, 1905, 12 noon, solar halo, 22°, well defined; continued until 2:30 p. m. Snow on the 29th.

February 1, 1905, 4 p. m., solar halo, 45°, brilliant. Cloudy and cold on the 2d; snow on the 3d.

February 7, 1905, 1 p. m., solar halo, 22°, well defined, lasting one hour. Snow began falling soon after 12 midnight and continued during the 8th.

February 10, 1905, 10 a. m., solar halo, 22°, exceptionally well defined, continuing until 12 noon; clouds changing from cirro-stratus to alto-stratus. Snow began at 4 a. m. of the 11th, continuing thru the entire day.

February 12, 1905, snow continued during the night of the 11th and the greater part of the 12th; at 4 p. m. the sky cleared, showing a faint halo; at 4:30 p. m. a perfect parhelion was observed. Weather on the 13th cloudless and very cold; temperature 25° below zero.

February 18, 1905, 9 a. m., solar halo, 45°, very bright, lasting until 2:30 p. m. Increasing cloudiness after 3 p. m.; complete cloudiness at 4:30 p. m. A faint lunar halo was observed at 11 p. m. Snow began soon after 7 a. m. of the 19th, continuing during the day.

March 1, 1905, 10:30 a. m., solar halo, 45°, very bright, lasting until 12:30 p. m. The 2d opened with dense fog, followed by clear and pleasant weather.

March 4, 1905, 4 p. m., solar halo, 22°, faint; fading and reappearing until 5:25 p. m. Fair and pleasant on the 5th.

March 5, 1905, solar halo, 22°, bright and well defined, lasting until 12 noon. The morning of the 6th was cloudy and threatening; rain fell in the afternoon.

March 26, 1905, 2:15 p. m., solar halo, 22°, moderately well defined, lasting until 4:30 p. m. Thunder with showers on the 27th.

April 11, 1905, 4:30 p. m., solar halo, 22°, faint. Cool and cloudless next day.

April 22, 1905, 8:30 a. m., solar halo, 45°, lasting until 4 p. m., well defined, especially brilliant from 10 a. m. until 11:30 a. m. Unsettled weather on the 23d; rain and thunder during following night and next day, the 24th.

May 14, 1905, 7:45 p. m., lunar halo, 21°, quite well defined, lasting until 9:30 p. m. Thundershowers afternoon of the 15th.

May 18, 1905, 10 a. m., solar halo, 45°, very fine and bright, lasting until 2 p. m. At 9 p. m., lunar halo, 22°. Clear, with normal temperature on the 19th.

May 24, 1905, 9 a. m., solar halo, 45°, bright and well defined. Thundershowers on the 25th.

May 29, 1905, 11 a. m., solar halo, 22°, well defined, but lasting only a short time. Light rain the same afternoon and the next day.

June 14, 1905, 2 p. m., solar halo, 45°, well defined, Generally clear and warm on the 15th.

June 16, 1905, 2 p. m., solar halo, 22°. Weather unsettled on the 17th, but no rain.

September 14, 1905, 9 a. m., solar halo, 22°, lasting until noon; very bright and well developed. Showers late in the afternoon of the same day, continuing during the night and the next day.

October 13, 1905, 2:30 p. m., solar halo, 22°, bright; lunar halo at 8:15 p. m. 22°, bright. Thunderstorms and rain on the 14th.

December 8, 1905, 10 p. m., lunar halo, 45°, very bright and well defined. (Hurricane crossing Florida.) No rain on the 9th.

December 9, 1905, 2 p. m., solar halo, 45°, well defined. (Hurricane off South Atlantic coast.) Cloudless skies, with bracing, cool temperature on the 10th.

December 12, 1905, 3 p. m., solar halo, 45°, well defined. (Storm along Texas coast.) Weather clear on the 13th.

December 17, 1905, 11 a. m., solar halo, 45°, very fine. Weather generally clear on the 18th.

December 18, 1905, 8:30 a. m., solar halo, 45°, brilliant for half an hour. (Storm in Rio Grande Valley.) Cloudy on the 19th; rain and snow on the 20th.

December 30, 1905, 10 a. m., solar halo, 22°, pale. Light snow night of the 30th.

January 5, 1906, 12:30 p. m., solar halo, 22°, pale. Weather clear on the 6th.

January 18, 1906, 1:30 p. m., solar halo, 22°, pale. Fair next day.

January 19, 1906, 10 a. m., solar halo, 45°, well defined, lasting until 3 p. m. Rain soon after 12 midnight of the 20th.

January 20, 1906, 9 a. m., solar halo, 22°, lasting two hours; at times very bright and at others pale and indistinct, alternating. Rain soon after 12 midnight, changing to snow on the 21st.

January 29, 1906, 7:15 p. m., lunar halo, 22°, bright. Fine weather on the 30th.

February 11, 1906, 1:30 p. m., solar halo, 45°, bright and well defined. Cloudy on the 12th; rain and snow on the 13th.

February 16, 1906, 2:30 p. m., solar halo, 22°, bright. Light snow during most of the forenoon next day.

April 3, 1906, 10:19 a. m., solar halo, 45°, bright and well defined. Rain began 4 p. m. of the 4th.

June 1, 1906, 7:45 a. m., solar halo, 45°, bright and well defined. Weather next day mostly clear.

June 2, 1906, 10:35 a. m., solar halo, 22°. Unsettled with showers on the 3d.

September 27, 1906, 12 m., solar halo, 45°, very bright and well defined, lasting until 3 p. m., but becoming pale and ill-defined at about 2:30 p. m. Cloudiness increased rapidly during the afternoon, and rain began at 2:30 a. m. of the 28th. (A Gulf storm of marked energy was near the mouth of the Mississippi at 7 a. m. of the 27th. The morning of the 27th was cloudless at Columbia; cirrus appeared, moving from the SSE., at about 11:35 a. m., changing rapidly to cirro-stratus. Alto-stratus appeared at about 2:30 p. m., then cumulus, strato-cumulus, and stratus, all within the following three hours.)

OBSERVATIONS OF HALOS AND CORONAS IN ENGLAND.

By M. E. T. Gheury. Dated Eltham, England, June 6, 1907.

Casual observers of halos and coronas can not realize how frequent these phenomena really are, as shown by the great number observed when they are made the object of systematic daily and nightly observations.

While I should have stated a few months ago, as an estimate of their probable number in these latitudes, that there might be yearly perhaps ten or so, taking as a basis my recollections of my observations of the previous years, a systematic inspection of the sky, begun this year, has yielded twice that number for the first quarter of the year only. They promise an interesting study both by the variable appearance of the phenomena themselves and by the different meteorological changes accompanying them. This number, however, may be quite exceptional; it is influenced by the age of the moon, since, in exactly similar favorable meteorological conditions, the presence or the absence of the moon above the horizon from nightfall to midnight will obviously make all the difference between such a phenomenon taking place or not.

On the other hand, one can not be always observing, and it is certain that a large number of phenomena are not recorded.

The present systematic observation was undertaken to ascertain if these phenomena—since their cause is purely an atmospheric one—could not be taken as the basis of forecasts of the approaching weather, and, incidentally, to test the theories brought forward by Prof. J. M. Pernter in his Meteorologische Optik, whenever they were displayed with sufficient brightness to lend themselves to accurate measurements with a sextant.

Before giving the results of the observations of the first quarter of this year, some remarks which were made in the course of these observations should be stated as a preliminary explanation of some of the observed phenomena.

Faint halos.—The observation of a faint halo requires great care and circumspection. A halo of that kind requires continuous attention to be discerned, especially when the sky is not uniformly veiled, as the halo may be but partly visible, and be lost amongst the bright patches of an irregularly